example, when a mud motor is utilized to rotate the drill bit, drill string torque and RPM are completely unrelated to drilling fluid pressure because the mud motor operates completely independently from the drill string. That is especially true when only the mud motor is utilized to rotate the bit. In that instance, there is no drill string torque and RPM because the drill string does not rotate. Consequently, the claimed invention includes a feature that permits various parameters to be eliminated from the control scheme when they are not necessary.

Exhibit A illustrates the values of the four drilling parameters required for a drilling operation employing a mud motor as the primary driver of the drill bit. Specifically, those parameters are 1245 pounds of weight on bit, 1700 psi of drilling fluid pressure "off bottom", 2,000 psi of drilling fluid pressure "on bottom", 170 foot pounds of drill string torque, and 70 RPM's for the drill string. The automatic driller of the claimed invention controls the release of a drill string utilizing interrelated parameters such as torque and RPM because regulators 200-203 (see Figure 2) are connected in series. The placement of regulators 200-203 in series permits the selection of one parameter as a primary control and the remaining parameters as secondary controls as described in the specification on page 35, line 32, through page 36, line 23.

The parameters illustrated in Exhibit A are determined by the drilling rig operator based upon the type of formation (e.g., Austin chalk), the specifications of the mud motor, the diameter and depth of the borehole, etc. For example, with the Austin chalk formation, the drilling rig operator selects a relatively low weight on bit of 1245 pounds because chalk is not a particularly hard/dense material. Based upon the above factors and the selected weight on bit, the drilling rig operator determines that the drill string must develop no more than 170 foot pounds of torque at 70 RPM's or damage may result to the drilling rig, drill string, or drill bit. Furthermore, the drilling rig operator determines that an "on bottom" drilling fluid pressure of 2,000 psi is required to

B

power the downhole mud motor as well as remove sufficient amounts of chalk from the borehole.

Unfortunately, utilizing only weight on bit to control the release of the drill string provides for extremely inefficient operations. Illustratively, the drill string often catches on the borehole, resulting in the actual weight applied to the bit being considerably less than the weight on bit registered at the surface. Furthermore, if another parameter changes (e.g., torque increases above 170 foot pounds) even though the weight on bit remains constant, damage to the drilling rig, drill string, or drill bit may result. Consequently, the claimed invention permits the control of the release of a drill string utilizing additional parameters.

If drilling fluid pressure provides the primary control for the example illustrated in Exhibit A, the drilling rig operator manipulates adjusting screw 214 such that flapper 213 deflects the appropriate amount of air to valve 236 (see Figures 2 and 3). An appropriate amount of air opens valve 236 such that valve 236 controls air motor 204 to release the drill string at a rate that maintains the drilling fluid pressure at 2000 psi.

After adjusting regulator 200, the drilling rig operator adjusts regulator 201 to provide a weight on bit that furnishes a secondary control. As previously described, the drilling rig operator determined the weight on bit should be 1245 pounds. Thus, to provide a secondary control, the operator manipulates adjusting screw 252 to adjust flapper 251 such that valve 237 opens an amount that provides an air flow corresponding to a weight on bit of 1260 pounds. Similarly, the operator adjusts regulators 202 and 203 such that their respective valves 238 and 239 open to permit an air flow corresponding to 175 foot pounds of torque and 75 RPM's.

Regulators 201-203, therefore, provide secondary controls because, during normal operation, regulator 200 maintains the drilling fluid pressure at 2000 psi, while the weight on bit remains at approximately 1245 pounds, the torque remains at approximately 170 foot pounds, and the RPM's remain at

approximately 70. Accordingly, as long as drilling operations remain normal, regulators 201-203 will not override regulator 200.

However, if for example the friction between the drill string and borehole increases to a point where the drill string snags thereby decreasing its rotational speed, an override by regulator 202 may occur. In such a situation, the drilling fluid pressure and weight on bit may remain relatively stable, while the torque and RPM change. The RPM will significantly decrease, however, because regulator 203 is a secondary control, any further opening of its valve 239 will not affect the release of the drill string. When the drill string snags, the torque rapidly increases and, if no overriding control occurs, damage will most likely result to the drill string and/or drilling rig. Once the torque exceeds the 175 foot pound secondary value, Bourdon tube 270 expands, resulting in flapper 271 retreating from nozzle 274. As a result, nozzle 274 delivers less compressed air to valve 238, resulting in valve 238 closing. When valve 238 closes to a point where it restricts the air flow to air motor 204 more than valve 236, regulator 202 controls the release of the drill string. Additionally, if the torque rises to a level that valve 238 completely closes, then the release of drill string completely ceases. Regulator 202 will control the release of the drill string until the torque returns to a level below the value set for the secondary control (i.e., 175 foot pounds). After the torque returns to a level below the set value, regulator 200 again controls the release of the drill string.

The remaining two secondary parameters of weight on bit and RPM operate identically as described for torque. Furthermore, if drilling fluid pressure were set to function as a secondary control, regulator 200 would function as described above for torque. Thus, if a situation occurs where a parameter exceeds the set secondary control value, the particular regulator assumes control as described above.

In a further illustration, if the friction between the drill string and borehole decreases such that the drill string RPM rapidly increases, regulator 203 will control the release of the drill string until the RPM's return to a level below the secondary control value. The torque will significantly decrease, however, because regulator 202 is a secondary control, any further opening of its valve 238 will not affect the release of the drill string. If the drill string RPM rapidly increases and no overriding control occurs, damage may result to the drill string and/or drilling rig. Once the drill string RPM exceeds the 75 RPM secondary value, Bourdon tube 290 expands, resulting in flapper 291 retreating from nozzle 294. As a result, nozzle 294 delivers less compressed air to valve 239, resulting in valve 239 closing. When valve 239 closes to a point where it restricts the air flow to air motor 204 more than valve 236, regulator 203 controls the release of the drill string. Additionally, if the RPM's rise to a level that valve 239 completely closes, then the release of drill string completely ceases. Regulator 203 will control the release of the drill string until the torque returns to a level below the value set for the secondary control (i.e., 75 RPM's). After the torque returns to a level below the set value, regulator 200 again controls the release of the drill string.

Applicant respectfully submits that a drilling rig operator having ordinary skill in the art will understand the relationship between the various drilling parameters and be able to set a primary control and as many secondary controls as desired. Essentially, after arriving at the desired drilling parameters, which is a matter of applying well known drilling technology, an operator may set the automatic driller of the claimed invention as previously described to control the release of the drill string. In view of Applicants description of each of regulators 200-203 and the discussion of a primary control parameter and secondary control parameters, Applicant respectfully submits that a person of ordinary skill in the drilling art could make and practice the claimed invention without undue experimentation. Applicant,

therefore, respectfully requests the withdrawal of the 35 USC §112, objection to the specification and corresponding rejection of claims 1-11 and 15-18.

Applicant respectfully traverses the rejection of claims 1-11 under 35 USC §103 by Ball in view of Rogers and further in view of the Gatlin publication. Ball discloses a standard weight on bit drill string control system. Rogers discloses that RPM and thrust (bit weight) of a coal mining drill may be manipulated by a computer to optimize the rate of penetration. The Gatlin publication discloses that weight on bit and rotational speed are interrelated with respect to the rate of drill bit penetration. Gatlin further discloses that the rate of drill bit penetration depends upon the hydraulic force of the drilling mud within the borehole. That is, higher drilling mud pressures expedites the removal of cuttings from within the borehole. Essentially, increased hydraulic pressures better clean the borehole, resulting in an increase in the allowable weight on bit applied during the drilling of the borehole.

With respect to claims 1 and 7, Applicant respectfully submits that the recognition in the Gatlin publication that hydraulic fluid affects the drilling rate does not disclose, teach, or fairly suggest to one of ordinary skill in the art that drilling fluid pressure may be utilized as a parameter to control the release of the drill string. Gatlin merely recognizes the obvious concept that the cleaner borehole the easier a drill bit will progress through it. Gatlin fails to disclose that variations in drilling fluid pressure indicate the position of a drill bit relative to bottom of borehole. The enhanced cleaning of a borehole through increased drilling fluid pressure is not in any way related to drill string control because increased pressures are obtained through regulation of pumping pressures. In the claimed invention, the pump pressure is set to a desired value and then is not altered during the drilling operation. Any changes in drilling fluid pressure registered by the claimed invention occur due to changes in the position of the drill string relative to the bottom of the

borehole. Consequently, Applicant respectfully submits that, because Gatlin fails to understand the relationship between drilling fluid pressure and the relative position of a drill bit within the borehole, Gatlin furnishes no disclosure or teaching that fairly suggests to one of ordinary skill in the art that drilling fluid pressure may be utilized to control the release of a drill string. Accordingly, Applicant respectfully submits claims 1 and 7 are allowable over Ball in view of Rogers and further in view of the Gatlin publication.

With respect to claims 3 and 4, those claims have been amended to depend from claim 1. Accordingly, Applicant respectfully submits that claims 2-4 are allowable predicated upon their dependence from claim 1.

Claims 5 and 6 are considered allowable through their inclusion of controlling the drill string utilizing drilling fluid pressure as outlined in the preceding argument.

Claims 8 and 9 have been amended to depend from claim 7 and, therefore, are considered allowable predicated upon that dependence and the preceding arguments.

Claims 10 and 11 include controlling the release of the drill string utilizing drilling fluid pressure. Accordingly, Applicant respectfully submits claims 10 and 11 are allowable.

In view of the forgoing, Applicant respectfully request reconsideration of the rejected claims and earnestly solicits early allowance of the application.

Respectfully submitted,

LAW OFFICES OF DONALD R. COMUZZI
1631 Milam Building
115 East Travis Street
San Antonio, Texas 78205
(210)225-0007

DATE: 7 November 1994

By: Christopher L. Makay
Reg. No. 34,475

ATTORNEY FOR APPLICANT

EXHIBIT "A"

PATTERSON DRILLING COMPANY

DAILY DRILLING RECORD

AFE #		DWC	29,538
		CWC	725,016

Frierson Unit 1-H	RIG Patterson 21	DAYS 26	DATE 20 Oct 94
LOCATION	PROJ. DEPTH:	DRLG SUPERVISOR R. Koehler	

6:00 AM STATUS	DEPTH	FOOTAGE	FORMATION	ROT. HOURS	LAST LOG	NEXT LOG
	12,243	176	Austin Chalk			
			OPERATION: RIH w/ 3½ DP to LDDP		CONTRACT SUPERVISOR: JW Mode	

DAILY SUMMARY

SPUD DATE 9-6-94 1100 hrs.

MUD CO Tejas ENGR Gamez

MUD DATA	IN	OUT
DEPTH		
TIME		
MW		
FV	F	
PV	R	
YP	E	
GELS		
API WL	S	
API CK	H	
HT HP WL		
HT HP CK		
PH	W	
PF	A	
CL	T	
CA		
OIL	E	
SOLIDS	R	
TEMP		
TYPE MUD		
DAILY $	1413	
CUM $	38273	

ADDITIVES

ADD	SX	ADD	SX
GEL		KO1200	3
CAUSTIC		CIB	3
BARITE			
PHPA	3		

CASING	PLANNED	ACTUAL	
9⅝ @		3714	RKB
7 @		7922	RKB
@			RKB
@			RKB

TRIP MUD CUT

ROT WT 105 PU WT 140

SLACK OFF WT 60

TORQUE 170 @ 70 RPM

DRAG @

PORE P. SHALE DENS

BACKGROUND GAS

CONN GAS

MAX GAS

TRIP GAS

TRIP CL

TRIP MUD CUT

BIT RECORD		
SIZE	6⅛	
NUMBER	RR9	
TYPE	HZ27	
MAKE	SEC	
GRADE	T B G	T B G
NOZZLES	3-15	
OUT	12,243	
IN	11333	
FOOTAGE	910	
HOURS	29	
ROP	31.3	
WOB	12-15	
RPM	70/mm	

PUMPS	1	2
LINER	5½	
STROKE	10	
SPM	65	
GPM		
PRESS	1700/2000	
SPR/SPM		
SPR PRES		

HYDRAULICS

AV-DP

AV-DC

JET-V

TOTAL WELL

ROT. HOURS

TIME BREAKDOWN

DRLG	5½	SURVEY	2 WL	CIRC	1	FISHING	
TRIP	4	LOGS		WOC		TOOLS	1
RIG REPAIR		CSG		CORE		NU	
SERV RIG	½	CMT		W&R		OTHER	10

	LENGTH	CALC FILL-UP	DIF
DP			
HW			
DC			

HOURLY OPERATION SUMMARY FROM 0600 HOURS

TO	HOURS	OPERATION
0600-0800	2	DRLG - Rotate 12067-12,136
-0830	½	Rig Svc
-1130	3	DRLG - rotate 12,136-12231
-1200	½	Pull wet connect - wire stranded below pack off
-1230	½	DRLG - rotate 12231-12243
-1400	1½	Strip out with 54 stds.
-1530	1½	Pull steering tool, wet connect, RD wireline
-1630	1	Kill well
-1830	2	POOH w/ motor
-1930	1	LD directional tools
-0030	5	RU Paragon WL, run Baker Retrieva D - would not set, POH w/ packer
-0330	3	WO wireline firing pin, new Baker firing head
-0530	2	RIH w/ packer - Set @ 7360', RD wireline
-0600	½	Trip 1H w/ DP

MAX CSG PRESS 400

MOTOR HRS. 29

TD 12,243 MD, VS 4499

EST FLUID LOSSES DAILY - 2400

CUM 20,053

BOTTOM HOLE ASSEMBLY

29.0

WT

HRS